Energy Change

(Chapter 5)

The Nature of Energy

Part 1

Outline

- Energy
- Thermochemistry
- Transfer of Energy
- Systems and Surroundings
- Heat (Q)

Nature of Energy

- Energy is all around you!
  - You can hear energy as sound.
  - You can see energy as light.
  - And you can feel it as wind.

Forms of Energy

- The five main forms of energy are:
  - Heat
  - Chemical
  - Electromagnetic
  - Nuclear
  - Mechanical

Energy

- Energy- the capacity to do work or produce heat

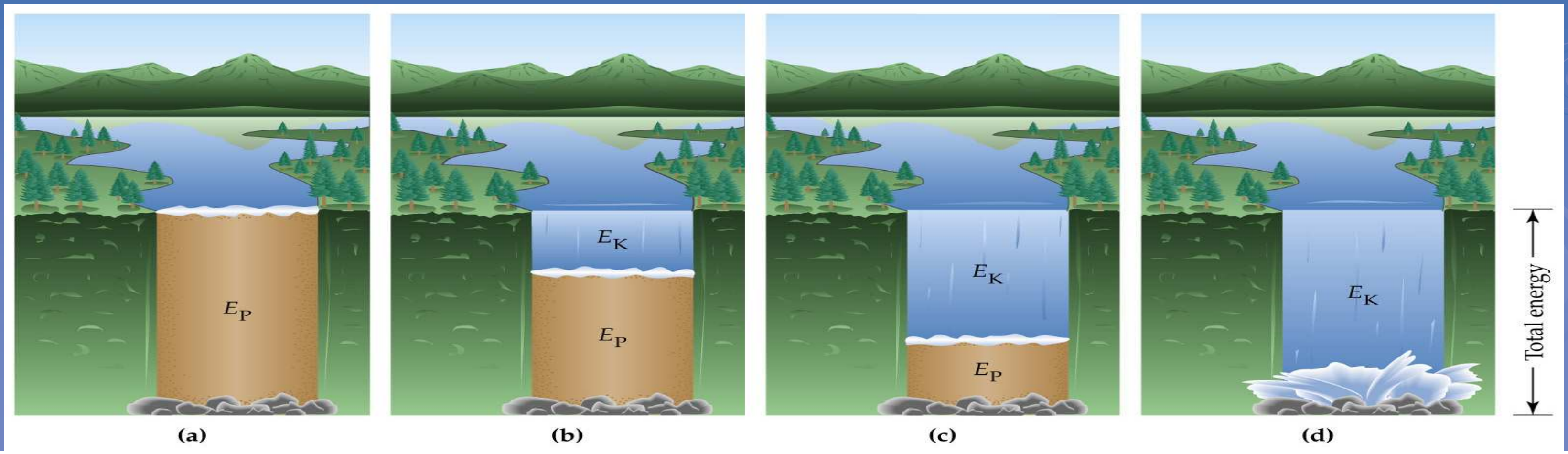
- Change in matter can involve the release or energy or absorption of energy
- Regardless of chemical or physical change, all changes in matter involve changes in energy

Thermochemistry

- Thermochemistry- the study of the energy involved in chemical and physical processes
- Observing and measuring the amount of heat that is released in these processes

Types of Energy

- Potential energy- (PE) due to position or composition
  - ex. attractive or repulsive forces
- Kinetic energy- (KE) due to motion of the object
  - $KE = \frac{1}{2}mv^2$:depends on mass and velocity



Transfer of Energy

- Temperature- measure of the average kinetic energy of the particles

- Two Ways to Transfer Energy:
  - Heat- (Q) transfer of energy between two objects because of a temperature difference
  - Work- (w) force acting over a distance

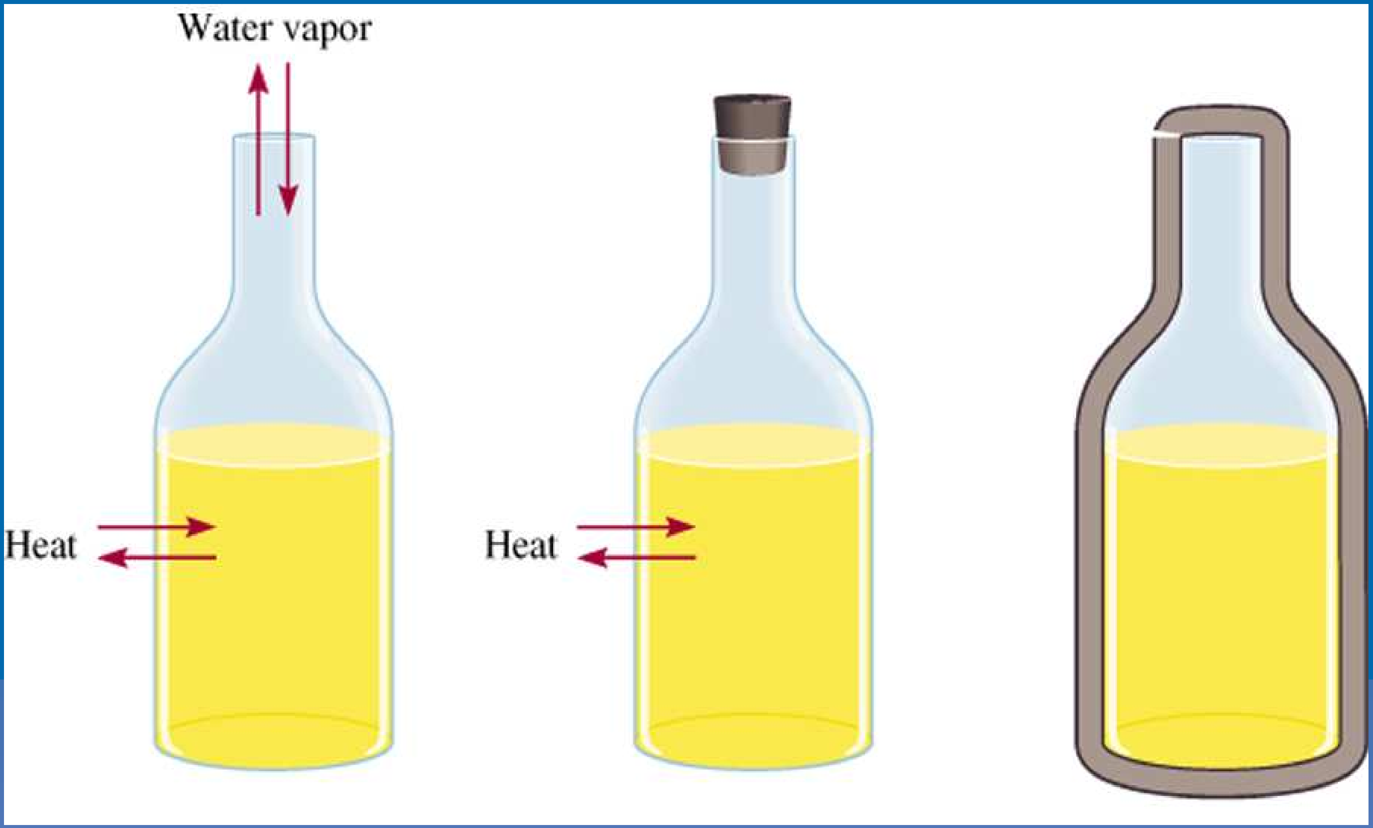
Pathway

- The specific conditions of energy transfer
- Energy change is independent of pathway because it is a <u>state function</u>
- Work and heat depend on pathway so are not state functions
- <u>State function-</u> depends only on current conditions, not past or future

Transfer of Energy

- system- part of the universe you are focused on
- surroundings- everything else in the universe
- usually
  - system: what is inside the container
  - surroundings: room, container, etc.

Types of Systems

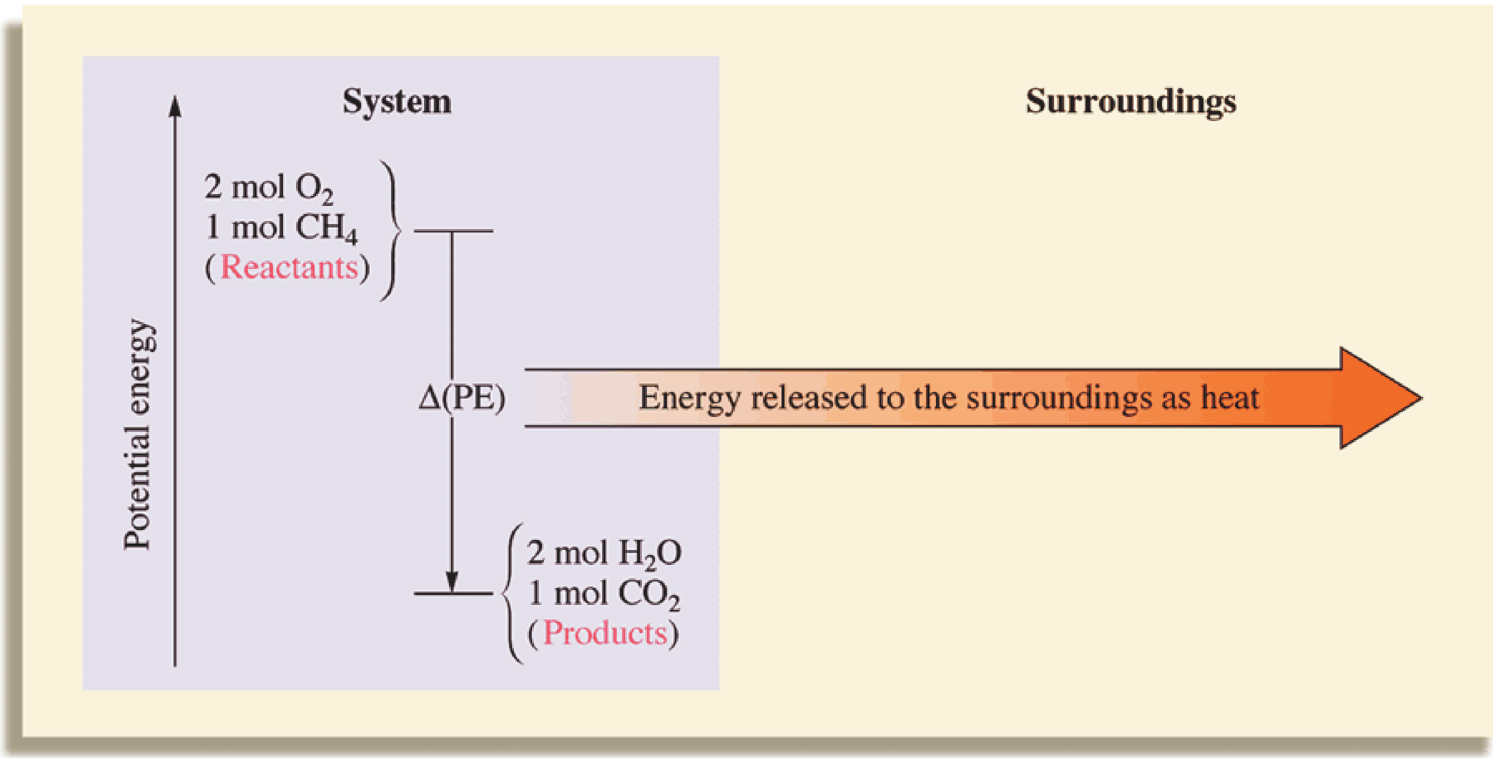


	Open	Closed	Isolated
Exchange:	Mass & Energy	Energy	None

Transfer of Energy

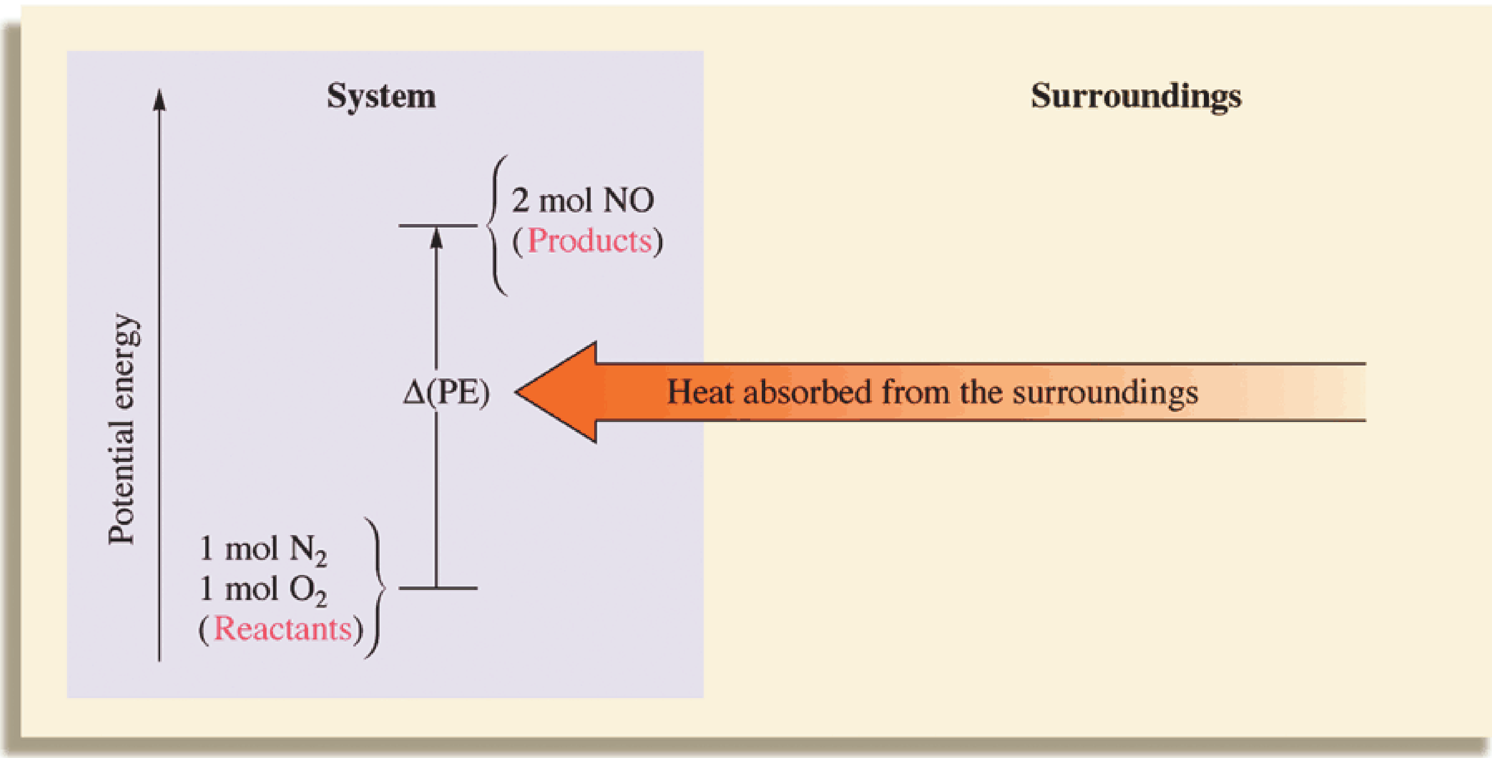
- exothermic-
  - energy is produced in reaction
  - flows out of system
  - container feels hot to the touch
- endothermic-
  - energy is consumed by the reaction
  - flows into the system
  - container feels cold to the touch

Transfer of Energy



Combustion of Methane Gas is exothermic

Transfer of Energy



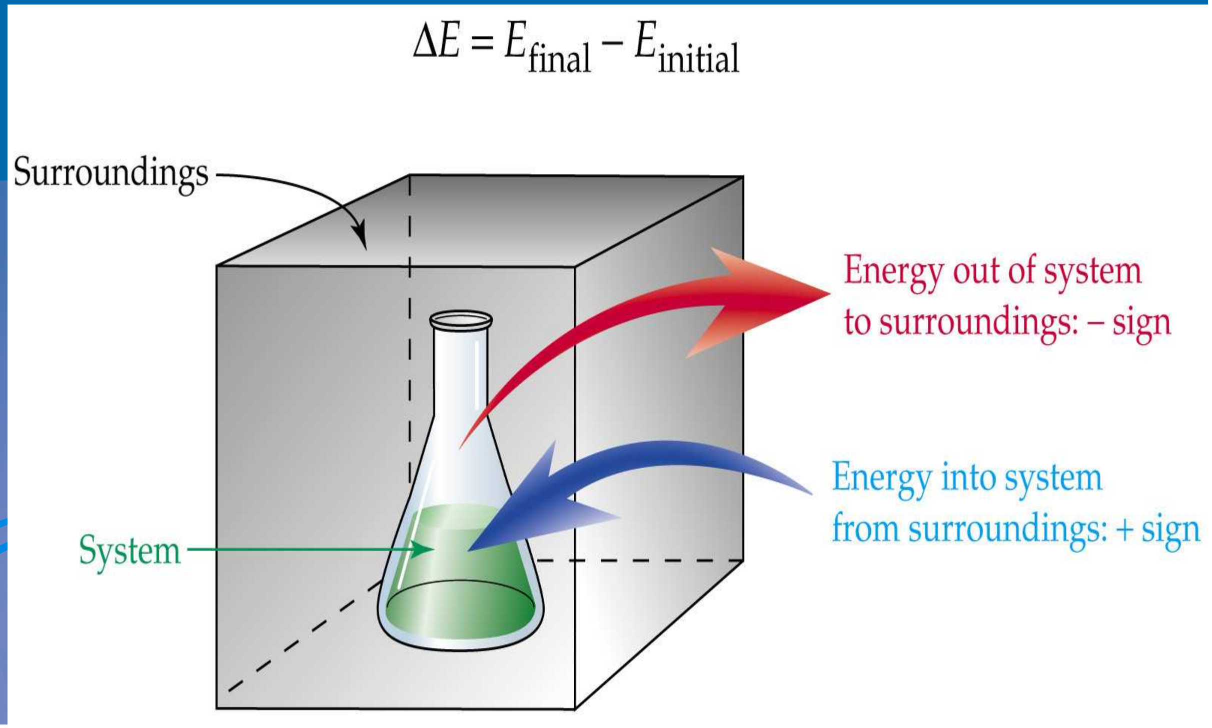
Reaction between nitrogen and oxygen is endothermic

Transfer of Energy

- the energy comes from the potential difference between the reactants and products
- energy produced (or absorbed) by reaction must equal the energy absorbed (or produced) by surroundings
- usually the molecules with <u>higher potential energy</u> have <u>weaker bonds</u> than molecules with lower potential energy

Internal Energy

- (E) sum of potential and kinetic energy in system
- can be changed by work, heat, or both
- E = PE + KE
- $\Delta E = q + w$



Heat (*Q*) absorbed or released

$$Q=mc\Delta T$$

Q= amount of heat transferred (Joules, J)

m= mass of a substance (g)

c= specific heat capacity (J/g• ^{0}C)

$\Delta T = T_{final} - T_{initial}$ (change in temperature) (^{0}C)

- 1 Joule = the amount of heat (*Q*) required to raise the temperature of **one gram** of the substance by **one degree** Celsius.
- The **specific *heat capacity*** (***c***) of a substance is the amount of heat (*Q*) required to raise the temperature of **a given quantity** (*m*) of the substance by **one degree** Celsius.

Specific Heat Capacities

- Refer to page 280 in your textbook for a comprehensive chart

Substance	**c (J/g^{0}C)**
Ammonia (l)	4.70
Ammonia (g)	2.06
Ethanol	2.44
Water (s)	2.00
Water (l)	4.19
Water (g)	2.02

Heat Examples

1) When a 1.25kg sample of water was heated in a kettle, its temperature increased from 16.4^{0}C to 98.9^{0}C. How much heat did the water absorb?

2) How much heat must be added to 128.62g of steam at 126.0^{0}C to increase its temperature to 189.5^{0}C?

3) A solid substance has a mass of 250.0g. It is cooled by 25.00^{0}C and loses 4.937kJ of heat. What is the specific heat capacity of the substance?

Additional Examples

1) How much heat is released when the temperature of 789g of liquid ammonia decreases from 82.7^{0}C to 25.0^{0}C?

2) On a warm day, how much solar energy does a 3.982kg piece of concrete absorb as heat if its temperature increases from 13.60^{0}C to 14.50^{0}C?

Homework

- Readings (pgs. 278-283)
- Questions (pg. 281) #7, 8
- Questions (pg. 291) #2, 6, 7